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October 9, 2003

DECLARATION

The undersigned, Dana Scruggs, having an office at 8902B Otis Avenue, Suite 204B, Indianapolis, Indiana 46216, hereby states that she is well acquainted with both the English and German languages and that the attached is a true translation to the best of her knowledge and ability of HILBURGER, U., ET AL, entitled "Device for Supplying a Process Chamber with Fluid Media".

The undersigned further declares that the above statement is true; and further, that this statement was made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any patent resulting therefrom.


Dana Scruggs

1 DEVICE FOR SUPPLYING A PROCESS CHAMBER WITH FLUID MEDIA

2
3 The present invention relates to a device for supplying a process chamber with
4 fluid media, having at least one delivery line that has a supply opening, and
5 having sealing elements that are associated with the supply opening. The
6 present invention also relates to the application of such a device for
7 manufacturing products, in particular metal alloys or for growing crystals.

8
9 With modern industrial processes for manufacturing materials, such as metal
10 alloys or for growing crystals, high process temperatures of 1500° Celsius and
11 higher are required in some cases. In addition, it is often necessary to use
12 reactive and/or corrosive gasses or carrier gasses. These various gasses must
13 then be withdrawn. The process chamber that is used is often operated in a
14 vacuum chamber. Tube connections that are stably joined via threaded
15 connections are commonly used for supplying a process chamber. At high
16 temperatures, however, thermal expansion of the threaded connections is
17 problematic. In addition, in many production processes, the process chamber
18 must be removed for loading, or to withdraw it from the vacuum chamber. When
19 a threaded connection is used, extensive assembly work is required to
20 accomplish this.

21
22 On the other hand, using open crucibles and gas lances results in contamination
23 of the vacuum chamber and high gas consumption, because the entire vacuum
24 chamber must be charged continually with reaction gasses.

25
26 Heating elements, sensors and vacuum components are often located in the
27 vacuum chamber. These individual components also come in contact with the
28 process gasses, which produces considerable stress on the individual
29 components. In addition, temperature regulation is made markedly more difficult
30 due to the pressure change that occurs in the process.

31

1 The object of the present invention is to create a device for supplying a process
2 chamber with fluid media, the device allowing a process chamber to be reliably
3 supplied with fluid media and making it possible to load the process chamber in a
4 rapid and uncomplicated manner, or to remove the produced material therefrom.

5
6 This object is achieved using a device of the type mentioned initially, with which
7 tensioning mechanisms are provided for holding the delivery line against a
8 receptacle of the process chamber that is associated with the supply opening

9
10 Since, with this device, a threaded connection need not be loosened in order to
11 load the process chamber or to remove the material that is produced, but,
12 instead, it is only necessary to push the delivery line back against the tensile
13 force of the tensioning mechanism, easy and simple handling is achieved with
14 the device having the features of the present invention. A reliable supplying of
15 fluid media is guaranteed through the supply opening and the receptacle
16 associated with said supply opening via the delivery line. In this manner, it is
17 possible to supply process gasses as well as carrier gasses. In addition, the
18 required amount of gas can be withdrawn from the process chamber. If the
19 process chamber is located in a vacuum chamber, the leakage rate is very low,
20 and it depends on the tightness of the connection of the delivery line with the
21 receptacle in the process chamber. In addition, said device for supplying fluid
22 media is also suitable for use at high temperatures and with corrosive media if
23 the proper material is selected, because sealing material that is susceptible to
24 corrosion need not be used in high temperature ranges. On the other hand, the
25 thermal expansion of the delivery line is reliably compensated for by the
26 tensioning mechanisms at high temperatures as well.

27
28 The tensioning mechanisms can include at least one spring, in particular a helical
29 spring. In this manner, the required tensioning force can be provided or adjusted
30 in a simple manner.

1 It is an advantageously if it is possible to produce the tensioning force using
2 ambient pressure. Since the stated process chamber is often operated in vacuum
3 chambers, the difference between the chamber pressure and ambient pressure
4 is often available, so that ambient pressure can be used in simple fashion to
5 produce the tensioning force.

6
7 In addition, a guideway for the delivery lines in the tensioning direction has
8 proven advantageous. Said guideway makes it easier to bring the supply
9 opening together with the receptacle that is associated with it.

10
11 The delivery line can be connected to a receiving chamber that surrounds the
12 process chamber in a gas-tight and axially displaceable manner at the end
13 furthest from the supply opening with fastening elements for gas-tight mounting.
14 Since the receiving chamber is usually cooled to acceptable temperatures, only
15 minimal requirements are placed on the fastening elements and the mechanical
16 elements for displacement at high process temperatures as well. For example,
17 the furthest end can be fastened to a central body that is connected with a
18 mounting flange by a bellows.

19
20 The central body can then be displaceably guided on at least one bolt that
21 extends out of the mounting flange. The spring is then located between a spring
22 hanger that is located on the bolt and the central body. This results in good
23 guidance of the delivery line and holds it down securely. If three bolts are used,
24 for example, this results in secure, parallel guidance, and tilting is reliably
25 prevented.

26
27 In a further development, adjusting mechanisms are provided for adjusting the
28 tensioning force. For example, the bolt can be a threaded bolt, and the spring
29 hanger can be a nut located on the bolt. By screwing the nut on the threaded
30 bolt, the spring force and, therefore, the tensioning force may be adjusted.

31

1 In another further development, the sealing mechanism is a press fit. Such a
2 press fit has a suitable configuration of the frontal area that surrounds the supply
3 opening and of the associated receptacle, said configuration having been
4 designed to fit. For example, the press fit can include an end face of the delivery
5 lines that is conical, frusto-conical or semi-spherical and that surrounds the
6 supply opening, and the receptacle of the end face has a conical, frusto-conical
7 or semi-spherical cavity associated with the end face. This provides the press fit
8 with a self-centering effect. In any case, the end face and the receptacle should
9 be suitably configured relative to each other, e.g., they should be machined to fit.
10 It is also possible for the end face or the cavity to have a bezel and for the other
11 element to have a flat surface.

12
13 In a particular embodiment of the invention, the delivery line can be composed of
14 a temperature-resistant and corrosion-resistant material. Graphite is an example
15 of suitable material.

16
17 In addition, an extension for the delivery line is advantageous. In this case, only
18 the part of the delivery line that directly abuts the process chamber need be
19 suitable for high temperatures and corrosive media, while the extension can be
20 composed of simple steel or corrosion-resistant steel or stainless steel, which is
21 simple to fasten. The delivery line and the extension can be screwed together, for
22 example.

23
24 In a further development of the invention, blocking elements for the delivery line
25 are provided. Preferably, the blocking elements block the fluid medium at the
26 supply opening. In the blocked state, a large dead volume inside the delivery line
27 is not exposed to contamination, particularly at high process temperatures. As a
28 result, reaction products cannot separate out inside the delivery line.

29
30 One possible example of a blocking element is a needle valve, because it
31 permits the fluid medium to be blocked or to flow through. A valve needle of the

1 needle valve can have a conical, spherical or semi-spherical tip. A conical,
2 spherical or semi-spherical valve seat should be located in the region of the
3 supply opening, that is directed toward the valve needle and is associated with
4 said valve needle. If elements for actuating the needle valve are located on the
5 end of the delivery line that is furthest from the supply opening, they can also be
6 located outside of a vacuum chamber, for example. In any case, the temperature
7 stress and stress caused by corrosive media are less on the furthest end.
8 Preferably, said actuating elements can be fastened to the central body.

9
10 If, in a further development, the valve needle is preloaded with a predetermined
11 closing force on the valve seat, then a tight closing of the needle valve can be
12 reliably achieved. It is also possible to limit the closing force using said preload.
13 The weight of the valve needle can serve as the closing force, for example, if the
14 valve needle is located vertically over the valve seat. Then, no elements are
15 required for said closing force, which said elements would be subject to wear or
16 corrosion.

17
18 A tension element that is connected with the valve needle can be provided. The
19 valve needle may be actuated using said tension element. If it is possible to
20 transmit a tensioning force but not a compressive force using said tension
21 element, then the valve needle can indeed be retracted, but it cannot be closed
22 using force that is stronger than the predetermined closing force. The tension
23 element can have a first tensile part that is connected with the actuating element,
24 and a second tensile part that is connected with the valve needle, and the two
25 said tensile parts are interconnected in a limited area in a manner that allows
26 them to be displaced toward each other. A simple configuration results when the
27 first tension part and the second tension part are interconnected by an elongated
28 hole and a driver.

29
30 In a further development, the tension element is connected with one end of a
31 bellows, the other end of which is connected with the central body, and the one

1 end is displaceable in the longitudinal direction of the tension element using the
2 actuating element. In this manner, it is possible to guarantee the mimicking of
3 displacement of the needle valve with reliable sealing that may be used in an
4 ultra-high vacuum range as well.

5
6 The device according to the invention is particularly suitable for manufacturing
7 products that must be treated with aggressive agents in a reaction chamber,
8 such as metal alloys and pure or highly-pure—large-volume, in particular—
9 crystals, such as those used as lenses, for example, to manufacture electronic
10 components such as chips, in particular computer chips, telephone chips, etc.
11 The present invention therefore relates to the application of the device for
12 manufacturing said products as well.

13
14 An embodiment of the invention is explained in greater detail hereinbelow with
15 reference to the drawing.

16
17 Figure 1 is a schematic illustration of a device having the feature of the invention
18 for supplying a process chamber,

19
20 Figure 2 is an enlarged illustration of the media supply device in Figure 1, and

21
22 Figure 3 is an illustration of the media supply device in Figure 1 that is rotated by
23 90 degrees around the vertical axis.

24
25 Figure 1 is a schematic illustration of a device having the features of the present
26 invention for supplying a process chamber 10 with fluid media. Process chamber
27 10 is located in a vacuum chamber. Pumps for evacuating vacuum chamber 12
28 are not shown in the figure. In addition, a heating element and/or a thermal
29 insulator 13 for process chamber 10 is located in vacuum chamber 12, if
30 necessary. In Figure 1, process chamber 10 has a cover 14 with two receptacles
31 15 on its top side.

Media supply devices 11 each have a mounting flange 16, with which they are mounted on vacuum chamber 12. In the embodiment shown, mounting flange 16 is a CF flange. KF flanges or other suitable fastening elements can be used as well, however. A suitable fluoroelastomer, such as Viton, can be used as sealing material to seal mounting flange 16 on the vacuum chamber 12. Viton provides a reliable sealing effect with good corrosion resistance at temperatures of up to approximately 200° C, and even up to 300° C. If vacuum chamber 12 has water cooling, for example, suitable temperature conditions for using Viton as sealing material can be created. It is also possible to use metal seals as sealing material, for example, such as copper seals or aluminum seals.

Media supply devices 11 also each have a delivery line 17, each of which has a supply opening 18 on its end face that is closest to receptacle 15. In Figure 1, receptacles 15 are each shown as conical cavities, while the frontal areas of delivery lines 17 that are facing receptacles 15 are each spherical in shape. In this manner, a reliable sealing effect of the frontal areas in the recesses 15 is guaranteed, while ensuring suitable contact pressure. In the figure, a media supply device 11 serves to supply a reaction gas, while the other media supply device 11 serves to withdraw gas from process chamber 10. Delivery lines 17 are composed of a suitable, temperature-resistant and corrosion-resistant material. In the embodiment, delivery lines 17 are made of graphite.

Figure 2 is an enlarged illustration of a media supply device 11 of Figure 1, and Figure 3 is a view of media supply device 11 in Figure 2 that is rotated by 90 degrees around the vertical axis. Clearly shown in the figures is the fact that frontal region 19 surrounding supply opening 18 is configured hemispherical in shape. Delivery line 17 has an extension 20 on its end furthest from opening 18. In the embodiment shown, extension 20 is a stainless steel tube that is screwed together with delivery line 17 using a threaded connection 21. Extension 20 extends, displaceable in the longitudinal direction, through mounting flange 16, and is stably interconnected with a central body 22. With the embodiment shown,

1 said connection is obtained using a threaded connection. Other connections are
2 also possible, in principle, such as a vacuum-tight weld seam.

3
4 A bellows 23 surrounding extension 20 is located between mounting flange 16
5 and central body 22, said bellows being welded on each of its two ends in a
6 vacuum-tight manner with mounting flange 16 and central body 22.

7
8 As shown clearly in Figure 3, central body 22 is supported on mounting flange 16
9 in a manner that allows it to be displaced longitudinally on bolt 24. Two bolts 24
10 are provided in the embodiment shown. Three or four bolts can also be used,
11 however. Bolts 24 then result in a largely secure guidance of delivery lines 17. In
12 the embodiment, bolts 24 are configured as threaded bolts 24 that have an
13 external thread 25 in the upper region in the figure. Nuts 26, 27 are screwed onto
14 each external thread 25. A washer 28, 29 and a helical spring 30, 31 each are
15 located between nuts 26, 27 and central body 22. Nuts 26, 27 and washers 28,
16 29 each serve jointly as spring hangers on which helical springs 30, 31 each
17 bear. In this manner, central body 22 is supported on threaded bolt 24 with spring
18 action and in longitudinally displaceable fashion.

19
20 A T-piece 32 with a branch 55 for the supply or withdrawal of the fluid medium is
21 fastened on the end of central body 22 furthest from bellows 23. T-piece 32 is
22 screwed together with central body 22 in a vacuum-tight manner using screws
23 33. A further bellows 34 is located on the end of T-piece 32 that is furthest from
24 central body 22. The end of bellows 34 that is furthest from T-piece 32 is closed
25 with a blind flange 35. Blind flange 35 is screwed together with a flange 37 of
26 bellows 34 using screws 36. The side of blind flange 35 furthest from bellows 34
27 has a threaded bolt 38 that extends upward through a supporting plate 39 and
28 engages with a knurled nut 40 above the supporting plate 39. Threaded bolt 38 is
29 surrounded by a helical spring 41 between blind flange 35 and supporting plate
30 39. Supporting plate 39 is stably interconnected with central body 22 by two
31 distance elements 42. Two distance rods 42 are used as distance elements 42,

1 said distance rods having an external thread 43 on their end closest to central
2 body 22, with which said external thread said distance rods are screwed together
3 with internal threads 44 in central body 22. On their ends closest to supporting
4 plate 39, distance rods 42 are each screwed together with supporting plate 39
5 using screws 45.

6
7 A first tension part 46 is fastened to, namely screwed together with, the side of
8 blind flange 35 furthest from threaded bolt 38. The first tension part 46 is
9 fastened in a longitudinally displaceable manner to a second tension part 47 on
10 the end furthest from blind flange 35, the second tension part being connected
11 with a valve needle 48 on its end furthest from first tension part 46. First tension
12 part 46 has a groove 49 on its end closest to second tension part 47, in which
13 said groove a segment 50 is located. Segment 50 has an elongated hole 51 that
14 is engaged with a screw 52 that is screwed through the end of the first tension
15 part 46 and extends over groove 49. Second tension part 47 is screwed together
16 with valve needle 48 on its end furthest from first tension part 46. The end of
17 valve needle 48 furthest from second tension part 47 has a spherical frontal area
18 53 that faces a conical valve seat 54 that surrounds supply opening 18. Valve
19 needle 48, like delivery line 17, is also composed of a suitable, temperature-
20 resistant and corrosion-resistant material. In the embodiment shown, valve
21 needle 48 is composed of graphite. First tension part 46 and second tension part
22 47, on the other hand, are composed of a material having a certain elasticity.
23 Stainless steel is used for first tension part 46 and second tension part 47.

24
25 If, after the two media supply devices 11 are placed on vacuum chamber 12, the
26 vacuum chamber is evacuated, central body 22 and, therefore, delivery line 17,
27 are pressed into the vacuum chamber until springs 30 compensate for the
28 difference between the atmospheric pressure and the chamber pressure. By
29 screwing nuts 27 onto threaded bolts 24, additional tensioning force may be
30 exerted on central body 22 and, therefore, delivery line 17, using helical springs
31 31. In this manner, the particular delivery line 17 can be so loaded with a suitable

1 tensioning force into the particular receptacle 15 that frontal area 19 seals tightly
2 in receptacle 15 in a press fit. As a result, it is then possible to supply process
3 chamber 10 with the particular fluid medium furnished by media supply device
4 11. In the case of thermal expansion or fluctuation of chamber pressure in
5 vacuum chamber 12, delivery lines 17 can evade the tensioning force of the
6 particular spring 31 without incurring damage.

7
8 The closing force of valve needle 48 is determined substantially by its weight and
9 the weight of second tension part 47, since second tension part 47 is hung onto
10 first tension part 46 by longitudinal hole 51 and screw 52. By turning knurled nut
11 40 on threaded bolt 38, valve needle 48 can be lowered into valve seat 54 via
12 first tension part 46 and second tension part 47. After valve needle 48 rests with
13 its entire weight in valve seat 54, turning knurled nut 44 further does not increase
14 the closing force, however. Instead, screw 52 slides downward into longitudinal
15 hole 51 in a nearly resistance-free manner. In this manner, damage to valve
16 needle 48 or valve seat 54 caused by excessive closing force is prevented.
17 Likewise, if a component of media supply device 11 undergoes thermal
18 expansion, an undesirably great closing force is not obtained. Instead, valve
19 needle 48 with second tension part 47 can deflect upward at any time into
20 elongated hole 51.

21
22 With a further embodiment of media supply device having the features of the
23 invention, oil-tight sliding elements are used to guide said media supply device
24 into or through the vacuum chamber, for sealing purposes. Said sliding elements
25 may be used when the requirements placed on the chamber pressure and the
26 composition of residual gas in the chamber are minimal.

27
28 The device according to the invention is suitable in particular for growing large,
29 homogeneous monocrystals, among other things. The crystal raw materials
30 include raw materials, in particular, that contain the crystal material as well as
31 scavengers that react, in a homogenizing phase, with any impurities that may be

1 present, to form highly volatile substances. Preferable crystal materials are MgF_2 ,
2 BaF_2 , SrF_2 , LiF and NaF , whereby CaF_2 is particularly preferred.

3
4 The device is therefore suitable as well for manufacturing optical components for
5 DUV lithography and for manufacturing wafers coated with photoresist and,
6 therefore, for manufacturing electronic devices. The present invention therefore
7 also relates to the application of monocrystals produced using the device
8 according to the invention in the manufacture of lenses, prisms, light-conducting
9 rods, optical windows and optical devices for DUV lithography, in particular in the
10 manufacture of stepping motors and excimer lasers and, therefore, in the
11 manufacture of integrated circuits and electronic devices, such as computers that
12 contain computer chips, as well as other electronic devices that contain chip-like
13 integrated circuits.

14
15 In summary, the invention permits compensation for temperature-induced
16 changes in the dimension of the process chambers without having to worry that
17 the process chamber and/or the fluid delivery lines—that are typically formed by
18 pipes—will be damaged. The ability of the delivery lines to be longitudinally
19 displaced ensures that the tightness of the seating of the frontal area of the
20 delivery lines at the edge of the supply openings of the process chamber is
21 retained, even if the process chamber expands due to thermal causes. The
22 preload force with which the delivery lines are pressed against the process
23 chamber can be produced, in general, in various manners. One possibility is to
24 provide a spring configuration that presses the delivery lines in the direction
25 toward the process chamber. Such a spring configuration has the advantage that
26 the preload force can remain nearly constant—or at least change within a non-
27 substantial range—if process-induced changes occur to the pressure relationship
28 between the vacuum chamber and the environment, and if the process chamber
29 undergoes thermal expansion. A spring configuration having two elements that
30 work in opposite directions permits a precise adjustment of the contact force of
31 the delivery lines against the process chamber in the resting position, i.e., before

1 evacuation of the vacuum chamber has started. Such an evacuation is a second
2 possible source for a tensioning force that presses the delivery lines against the
3 process chamber. Within the framework of the invention it is possible to produce
4 the tensioning force simply using a spring configuration, in particular when a
5 vacuum environment is not required to carry out the process, or it is not desired,
6 or when the process even needs to take place in an overpressure environment.
7 Embodiments are also feasible with which the tensioning force on the delivery
8 lines is produced simply by a pressure differential between the outside
9 environment and the vacuum chamber. In many cases, a combination of the two
10 stated possibilities are used, i.e., a combination of a first preload force produced
11 by a spring configuration, and a second preload force produced by a vacuum in
12 the vacuum chamber.

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1

Reference Numerals

2

10	Process chamber	33	Screws
11	Media supply device	34	Bellows
12	Vacuum chamber	35	Blind flange
13	Thermal insulation	36	Screw
14	Cover	37	Flange
15	Receptacle	38	Threaded bolt
16	Mounting flange	39	Supporting plate
17	Delivery line	40	Knurled nut
18	Supply opening	41	Helical springs
19	Frontal areas	42	Distance rod
20	Extension	43	External thread
21	Threaded connection	44	Internal thread
22	Central body	45	Screw
23	Bellows	46	First tension part
24	Threaded bolt	47	Second tension part
25	External thread	48	Valve needle
26	Nut	49	Groove
27	Nut	50	Segment
28	Washer	51	Elongated hole
29	Washer	52	Screw
30	Helical springs	53	Frontal area
31	Helical springs	54	Valve seat
32	T-piece	55	Branch

3